WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2005LA31B

Title: Modeling Sediment-Controlled TMDLs for the Branched and Braided Networks of Waterways in Louisiana: Model Development and Application to the Amite River Basin

Project Type: Research

Focus Categories: Models, Solute Transport, Water Quality

Keywords: TMDL, Model, Stream Network, Reversing Flows, Sediment Pollution

Start Date: 03/01/2005

End Date: 02/28/2006

Federal Funds: $13,196

Non-Federal Matching Funds: $29,369

Congressional District: 6

Principal Investigator:
Zhi-Qiang Deng

Abstract

Sediment/siltation and low dissolved oxygen (DO) are identified as the main pollutants of the parent impairments for the 59 water bodies in Louisiana. The currently recommended or used models by the Louisiana Department of Environmental Quality do not include the method for modeling the transport of suspended sediment although the sediment oxygen demand is included. The main problem in including the suspended sediment lies in the lack of a sound and widely accepted model for simulation of the transport and fate of sediments in branched and braided channel networks, which is a typical characteristic of Louisiana waterways. Moreover, significant progresses have been made in the determination of some critical modeling parameters such as the longitudinal dispersion coefficient, hydraulic geometry relationships, etc. However, these new progresses have not yet been reflected in TMDL calculations for Louisiana water bodies.

The objectives of this project are (1) to develop a new sediment dispersion and transport model for steady flow based on characteristics of Louisiana waterways, (2) to provide the most accurate hydraulic geometry relationship for determination of the mean flow velocity based on discharge, (3) to provide the most accurate method for estimation of the longitudinal dispersion coefficient in Louisiana waterways, (4) to construct an unsteady

flow model that is capable of simulating the reversing flows or backwaters occurring in the braided networks of Louisiana waterways, and (5) to determine the Amite River TMDL for Sediment. The sediment dispersion and transport model will be developed based the characteristics of the sediment sources and the channel networks of Louisiana waterways. A semi-Lagrangian-based split-operator approach will be employed to solve the equations numerically. The most widely used three methods for estimation of the longitudinal dispersion coefficient in streams and rivers will be compared with the dispersion data measured in Louisiana waterways and the best one will be employed to calculate the dispersion coefficient in Louisiana waterways. One important feature of the Louisiana waterways is that most Louisiana streams retain a significant width and depth at zero flow. This feature will be taken into account in the estimation of the longitudinal dispersion coefficient and in the determination of the hydraulic geometry relationships. This project will present a new method for the computation of the flow and mass transport in the braided channel network. The basic idea behind the method is to first solve the concentration at each network junction and then solve the concentration in each channel reach. By so doing, the solution of the entire channel network can be simplified to the solution of the network junctions and the channel reaches. Using the new model developed specifically for branched and braided networks of Louisiana waterways, the Amite River Total Maximum Daily Load (TMDL) for Sediment will be determined in accordance with Section 303(d) of the Clean Water Act.

The new model developed in this project can be employed as a submodel and linked to other models recommended by the EPA and the Louisiana Department of Environmental Quality (LDEQ) for determination of TMDLs. Consequently, this project will improve current simulation models used in TMDL calculations.